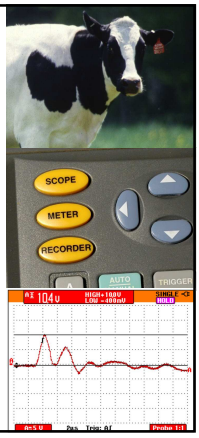
Oscilloscope Applications:
Hands-on modules



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Overview

We'll be seeing and practicing several different applications of oscilloscopes, from the very basic to advanced.

Modules

1. Oscilloscopes and cow behavioral response
2. Preliminary Setup
3. Getting signals to the scope
4. Capture, measure, and save a continuous waveform

Modules - continued

5. Capture a transient and measure it with cursors
6. Recording with an oscilloscope
7. Time of arrival test
8. Using a computer with a scope
9. Electrical fingerprints

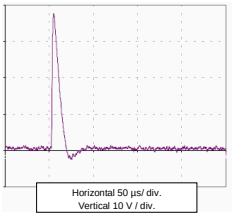
Module 1:
Oscilloscopes and cow behavioral response

Waveforms:

a)continuous, 20kHz sine, 5V peak amplitude

b)Transient

c)10 cycle, 60Hz, 1.5V RMS, sine

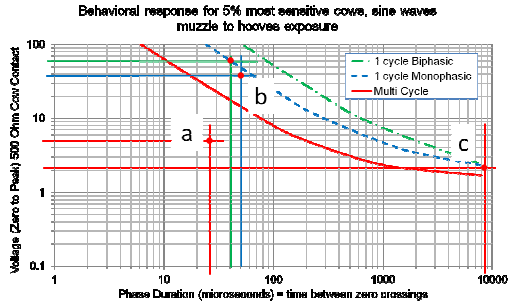


Module 1:
Oscilloscopes and cow behavioral response

a) What is the phase duration of a 20kHz sine wave?

$$phase\_duration(\mu s) = \frac{1{,}000{,}000}{2 * f(Hz)}$$

Module 1:
Oscilloscopes and cow behavioral response



Module 2:
Preliminary Setup

1. Clear memory and set to defaults
2. Time (and date if available)
3. Channel A: 1:1 voltage probe with DC coupling
4. Channel B: 100mV/A AC current probe

Module 2:
Preliminary Setup

Questions:

4 – Does the screen show probe attenuation and AC or DC coupling?

6 – Are probe attenuation and coupling settings saved after a reset? Are date and time saved?

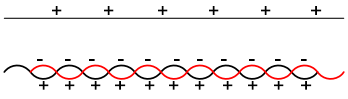
Module 3:
Getting Signals to Scopes

1) Big, open loop
2) Twisted pair
3) (better) twisted pair with shield

Module 3:
Getting Signals to Scopes

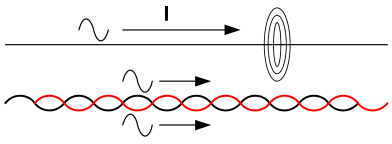
Twisted pair and capacitive coupling

- A nearby "aggressor" circuit is creating an electric field in the area of the twisted pair
- Twists help prevent differential voltage from developing between conductors in the pair



Module 3:
Getting Signals to Scopes

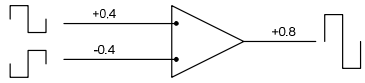
- Twisted pair and inductive coupling
  - A nearby "aggressor" circuit is creating a magnetic field in the area of the twisted pair
  - Twists force induced EMF to be "common mode"



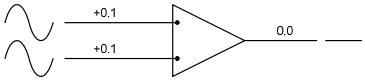
Module 3:
Getting Signals to Scopes

Isolated differential scope inputs

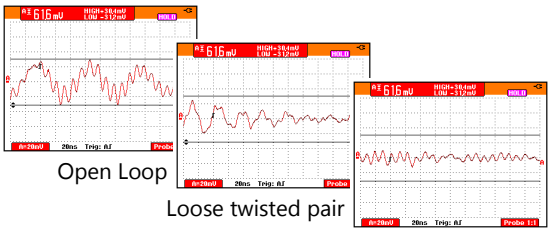
– The differential signal is extracted



– The common mode noise is cancelled



Module 3:
Getting Signals to Scopes



Open Loop

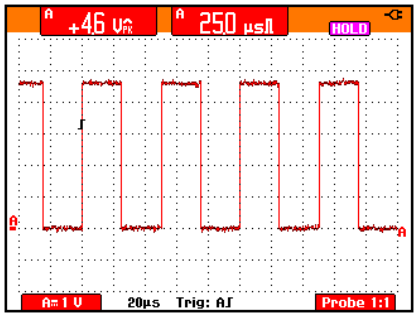
Loose twisted pair

Shielded twisted pair

Module 4:
Capture, measure, save a continuous waveform

1) Check probes
2) Connect low-voltage AC source
3) Experiment with trigger settings
4) Experiment with time and voltage scale
5) Set readings to zero-to-peak voltage and frequency or pulse width
6) Save and recall the scope screen

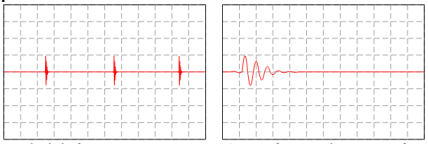
Module 4:
Capture, measure, save a continuous waveform



Module 5:
Capture a transient and measure with cursors

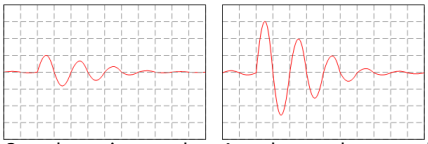
1) Check probes
2) Connect transient source
3) Adjust trigger, time, and voltage scales to get clear picture of the transient.
4) Measure zero-to-peak voltage with cursors
5) Measure phase duration with cursors
6) Compare your measurements with others

Module 5:
Capture a transient and measure with cursors



1: initial capture

2: reduce time scale

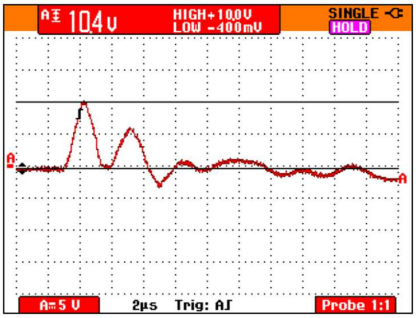


3: reduce time scale

4: reduce voltage scale

Module 5:

Capture a transient and measure with cursors



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Module 6:

Recording with an Oscilloscope

1) Check probes and connect to variable low voltage source
2) Use slow time scale to display a "band" rather than waveforms
3) Observe any transients
4) Try "trend-plot" if available.

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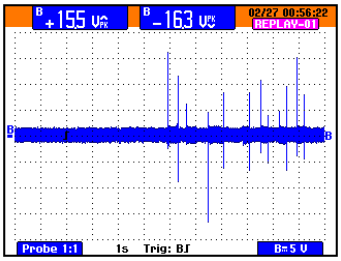
Module 6:

Recording with an Oscilloscope

Long time scale



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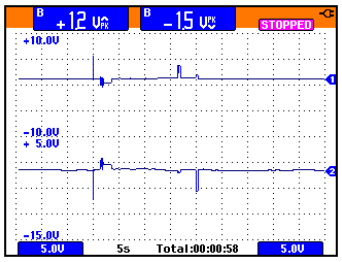
Module 6:

Recording with an Oscilloscope

Trend-Plot



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Module 7:

Time of arrival to find transient sources

1) Connect transient source to two channels of scope using one long and one short cable
2) Use short time span and catch leading edge of transient
3) Observe time delay for signal to travel through longer cable

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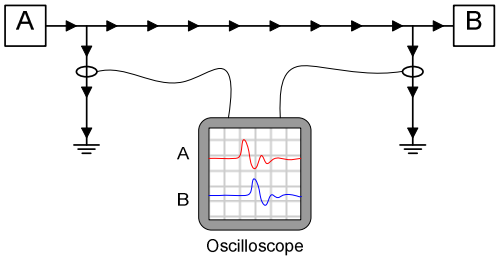
Module 7:

Time of arrival to find transient sources



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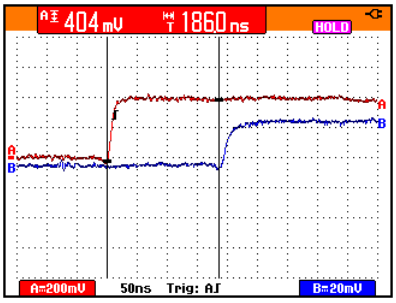
Module 7:
Time of arrival to find transient sources



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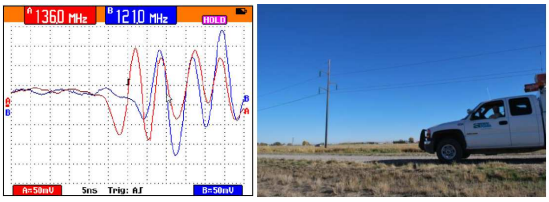
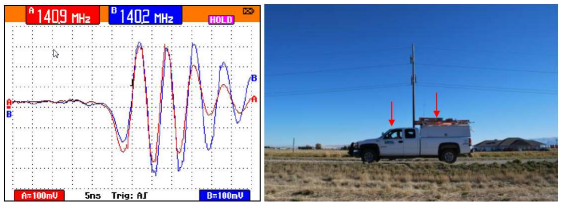
Time of arrival to find transient sources



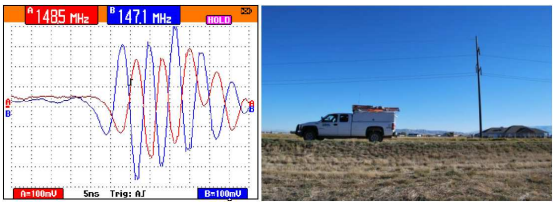
Approaching a noise source

Module 7:
Time of arrival to find transient sources



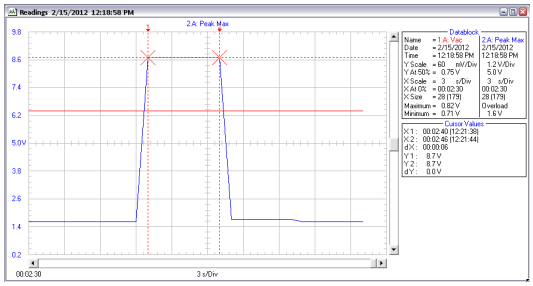
Both antennas are the same distance from the noise source

Module 7:
Time of arrival to find transient sources



Passing a noise source

Module 8:
Using a computer with a scope



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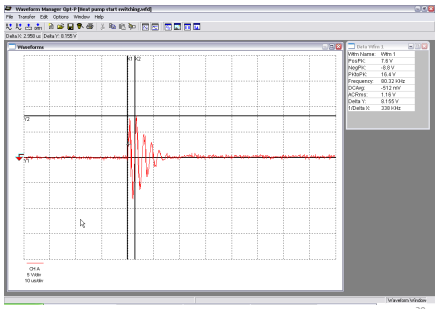
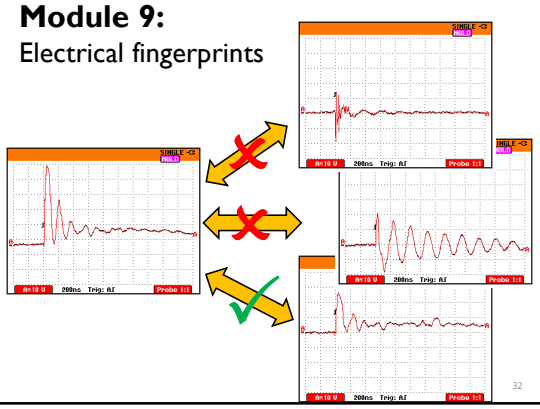
Using a computer with a scope



Module 9:
Electrical fingerprints

1) Connect scope to neutral-to-ground voltage at outlet, set to capture intermittent transients
2) Switch a load on and off. Capture "characteristic" switching transients
3) See if you can identify load from transient

Module 9:
Electrical fingerprints



Questions?